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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/737,315

12/15/2003

Ivo Raaijmakers

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10/21/2004

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EXAMINER

OWENS, DOUGLAS W

ART UNIT

PAPER NUMBER

2811

DATE MAILED: 10/21/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/737,315

Applicant(s)

RAAIJMAKERS ET AL.

Examiner

Douglas W Owens

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-26 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-25 is/are rejected.
- 7) ☒ Claim(s) 26 is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. ____ |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date <u>12/15/03</u> | 6) <input type="checkbox"/> Other: ____ |

DETAILED ACTION

Information Disclosure Statement

1. The information disclosure statement filed December 15, 2003 fails to comply with 37 CFR 1.98(a)(2), which requires a legible copy of foreign patent; each publication or that portion which caused it to be listed; and all other information or that portion which caused it to be listed. It has been placed in the application file, but the information referred to therein has not been considered. Several foreign references that were not cited in the parent application have not been provided in the instant application.

Claim Objections

2. Claims 19 – 22 are objected to because of the following informalities:
in claims 19 – 21, “runner” should be inserted after the second occurrence of “metal”; and
in claim 22, there is no antecedent basis for the term “the conductive lining layer”.
Appropriate correction is required.

Claim Rejections - 35 USC § 102

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

3. Claims 1 – 4 and 6 – 9 are rejected under 35 U.S.C. 102(e) as being anticipated by US Patent No. 6,368,954 to Lopatin et al.

Regarding claims 1, 10, and 11, Lopatin et al. teach a dual damascene structure (Figs. 2 and 9, for example) in an integrated circuit, comprising:

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a trench formed in an insulating layer;

at least one contact via extending from a floor of the trench downwardly to a conductive element (Col. 4, lines 19 – 26) below; and

a conductive lining layer (401) along surfaces of trench and the contact via, the lining layer having a maximum thickness of less than about 100 Angstroms (Col. 5, lines 29 – 32). Lopatin et al. do not explicitly disclose that the step coverage is greater than 90%, 93% or 97%. However, this step coverage is an inherent feature resulting from atomic layer deposition, as further evidenced in lines 21 – 24 of column 5 in US Patent No. 6,203,613 to Gates et al, which is cited here merely for additional evidence, not a suggestion of modifying Lopatin et al.

Regarding claim 2, Lopatin et al. teach a dual damascene structure, further comprising a metal (402, 403, 404) integrally filling the lined trench and contact via.

Regarding claim 3, Lopatin et al. teach a structure, wherein the conductive lining layer is a metal nitride layer (Col. 5, lines 20 – 25).

Regarding claim 4, Lopatin et al. teach a structure, wherein the metal nitride layer directly contacts the insulating layer and the conductive element (shown in Fig. 2 and 9; Col. 4, lines 25 – 35).

Regarding claim 6, Lopatin et al. teach a structure, wherein the metal nitride layer comprises titanium nitride (Col. 5, lines 20 – 25).

Regarding claim 7, Lopatin et al. teach a structure, wherein the metal nitride comprises tungsten nitride.

Regarding claim 8, Lopatin et al. teach a structure, wherein metal nitride comprises tantalum nitride.

Regarding claim 9, Lopatin et al. teach a structure, wherein the lining layer has a thickness of between 20 – 300 Angstroms, which includes the claimed range.

4. Claims 16 – 26 are rejected under 35 U.S.C. 102(e) as being anticipated by US Patent No. 6,479,902 to Lopatin et al.

Regarding claim 16, Lopatin et al. teach a metal structure in an integrated circuit (Figs. 1 – 4), comprising:

- a metal runner (204; Col. 3, lines 39 – 44 and Col. 4, lines 31 – 35) in an upper insulating layer (108);

- a metal contact (portion in via (206)) extending integrally from the metal runner through a lower insulating layer (122); and

- a metal nitride layer (130; Col. 5, lines 31 – 37) interposed between the upper insulating layer and the metal runner and interposed between the lower insulating layer and the metal contact, the metal nitride having a thickness in the range of 70 to 300 Angstroms, which includes the range of no more than about 200 Angstroms on any surface (Col. 5, lines 25 – 30).

Regarding claim 17, Lopatin et al. teach a metal structure, wherein the metal nitride has a thickness in the range of 70 to 300 Angstroms, which includes thicknesses within claimed range.

Regarding claim 18, Lopatin et al. teach a metal structure, wherein the metal nitride has a thickness on a bottom surface and sidewall of the metal contact that is

100% of the maximum thickness, which is also at least 93% of a maximum thickness of the metal nitride.

Regarding claim 19, Lopatin et al. teach a metal structure, wherein the metal [runner] and the metal contact comprise the same metal.

Regarding claims 20 and 21, Lopatin et al. teach a metal structure, wherein the metal [runner] is copper or aluminum (Col. 3, lines 39 – 44).

Regarding claim 22, Lopatin et al. teach a metal structure, further comprising a seed layer 232 overlying the conductive lining layer [metal nitride].

Regarding claim 24, Lopatin et al. teach a metal structure, wherein the seed layer comprises copper (Col. 4, lines 31 – 39).

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lopatin et al. as applied to claims 1, 3 and 4 above, and further in view of US Patent No. 6,479,902 to Lopatin et al.

Lopatin et al. do not teach a structure, wherein the conductive element comprises copper. Lopatin et al. is silent with respect to the preferred material of the conductive element. Lopatin et al. (6,479,902) teach a structure, wherein the conductive element (202) comprises copper. It would have been obvious to one having ordinary skill in the

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art to incorporate the teaching of Lopatin et al. (6,479,902) into the structure taught by Lopatin et al., since it is desirable to use low resistance materials for interconnection lines.

7. Claims 12 – 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lopatin et al. as applied to claim 1 above, and further in view of US Patent No. 6,627,539 to Zhao et al.

Lopatin et al. do not teach a structure, wherein width of the trench is less than 0.35 microns or 0.25 microns. Lopatin et al. do not teach a structure, wherein the contact via has a width of less than 0.35 microns or between 0.05 and 0.25 microns. In fact, Lopatin et al. is silent with respect to the dimensions of the dual damascene structure. Zhao et al. teach that the current trend in the art toward deep Submicron technology involves feature sizes of less than 0.35 microns (Col. 1, lines 24 – 27), including lines with a width of 0.25 microns (Col. 1, lines 56 – 64), which lies within the claimed range. It would have been obvious to one of ordinary skill in the art to incorporate the teaching of Zhao et al. into the device taught by Lopatin et al. since it is desirable to use line widths (trench widths) that are known to be of sufficient width for the intended use as an interconnection line.

8. Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lopatin et al. as applied to claims 16 and 22 above, and further in view of US Patent No. 6,117,781 to Lukanc et al.

Lopatin et al. do not teach a structure, wherein the seed layer comprises tungsten. Lopatin et al. teach a structure, wherein the seed layer can be a material

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which can be deposited by electroplating (Col. 4, lines 31 – 39). Lukanc et al. teach that tungsten can be deposited by electroplating (Col. 6, line 65 – Col. 7, line 1). It would have been obvious to one of ordinary skill in the art to incorporate the teaching of Lukanc et al. into the device taught by Lopatin et al., since it is desirable to use materials that are well suited for the intended use.

9. Claim 25 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lopatin et al. as applied to claim 16 above, and further in view of US Patent No. 6,664,192 to Satta et al. Lopatin et al. do not teach a metal structure, wherein the metal contact has a depth to width ratio of greater than about 2:1. Satta et al. teach that in the state of the art damascene openings often have aspect ratios of greater than 2:1 (Col. 5, lines 23 – 28). It would have been obvious to one of ordinary skill in the art to incorporate the state of the art teaching of Satta et al. into the structure taught by Lopatin et al. since it is desirable to use feature ratios that are known to be reliable.

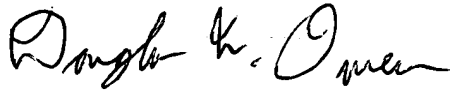
10. Claim 26 is objected to as being dependent upon a rejected base claim.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Douglas W Owens whose telephone number is 571-272-1662. The examiner can normally be reached on Monday-Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie C Lee can be reached on 571-272-1732. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

A handwritten signature in black ink, appearing to read "Douglas H. Owens". The signature is fluid and cursive, with the first name "Douglas" being the most prominent.

Douglas Owens
Patent Examiner